CHAPTER 28

MANAGEMENT OF OSTEOARTHRITIS AND RHEUMATOID ARTHRITIS

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Introduction

The term arthritis comprises a complex of diseases that affect more than 70 million people in the United States. Arthritis can manifest in more than 100 forms. This chapter focuses on rheumatoid arthritis and osteoarthritis and provides an analysis and discussion of the rehabilitation management of these two conditions.

Osteoarthritis

Epidemiology and Pathophysiology

Osteoarthritis (OA) involves the entire joint but is primarily a disease of the cartilage (Figure 28-1). OA affects nearly 40 million people in the United States and is the second leading cause of disability. The exact pathogenesis is unknown. The most commonly affected and symptomatic joints are the apophyseal joints of the spine, the distal and proximal interphalangeal joints, the carpometacarpal joints, the first metatarsophalangeal joint, and the knee, hip, and patellofemoral joints. The clinical features of OA are presented in Table 28-1.

<table>
<thead>
<tr>
<th>Joints Commonly Affected by Osteoarthritis</th>
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</thead>
<tbody>
<tr>
<td>- Spinal apophyseal joints</td>
</tr>
<tr>
<td>- Proximal interphalangeal (PIP) joints</td>
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<tr>
<td>- Distal interphalangeal (DIP) joint</td>
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<td>- Carpometacarpal (CMC) joints</td>
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<tr>
<td>- First metatarsophalangeal (MTP) joint</td>
</tr>
<tr>
<td>- Hip</td>
</tr>
<tr>
<td>- Knee</td>
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<tr>
<td>- Patellofemoral joints</td>
</tr>
</tbody>
</table>

Risk factors for OA can be classified into two major categories: intrinsic risk factors and extrinsic risk factors. Intrinsic factors include knee alignment (a determinant of joint load), muscle strength, obesity, ligament laxity, and proprioception. Extrinsic factors include repetitive physical activity and injury. Osteoarthritis is commonly referred to as osteoarthrosis. Although OA used to be considered a degenerative joint disease, this designation is no longer appropriate. Scientists now recognize that OA is a slowly progressing, dynamic disease that involves biomechanical, environmental, genetic, and biochemical factors (e.g., cytokines).

Our understanding of OA has increased considerably over the past 10 years, partly as a result of advances in cartilage imaging techniques. Early OA is a focal disease that presents as a distinct lesion of the cartilage. Patients with early OA have joint stiffness and progressive cartilage destruction with pain on loading of the affected joint. Over time, OA involves the entire joint, including the subchondral bone. Lesions progress with repeated biomechanical loading, synovial membrane inflammation, and release of...
cytokines; this stimulates the production of matrix metalloproteinases, which cause cartilage degradation and loss. Eventually the joint surface is destroyed. The classic appearance of primary OA on radiographs is localized disease with evidence of unequal joint space narrowing, eburnation (a hard, white appearance) of the subchondral bone, osteophytes, and subchondral cysts (Figure 28-2). These findings increase in frequency after age 50. Only 40% of patients with severe radiographic features present with pain.6,7

The radiographic features of OA are graded according to specific criteria. The Kellgren scale is commonly used for this purpose (Table 28-2). On radiographs, secondary OA may appear as diffuse or localized disease, depending on the etiology (e.g., rheumatoid arthritis [RA], diabetes, or trauma). Secondary contractures occur around the involved joint and contiguous joints. These contractures alter joint alignment and can increase the biomechanical forces on the joint, accelerating cartilage loss and increasing energy requirements for activities.

### Table 28-1

**Pathology and Clinical Features of Rheumatoid Arthritis and Osteoarthritis**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Tissue Predominantly Involved</th>
<th>Clinical Features</th>
<th>Radiographic Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rheumatoid arthritis (RA)</td>
<td>Synovium (inflammation)</td>
<td>Symmetrical and bilateral joint involvement</td>
<td>Periarticular swelling, joint effusion, regional osteoporosis, subchondral osteolytic erosions, joint subluxation</td>
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<tr>
<td></td>
<td></td>
<td>Joint pain, swelling, stiffness, and contracture</td>
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<td></td>
<td></td>
<td>Muscle weakness and fatigue</td>
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<td></td>
<td><em>Acute:</em> Red, hot, swollen, painful joints; boggy feel, fatigue, with or without fever; ligamentous laxity; morning stiffness up to a few hours</td>
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<td><em>Subacute:</em> Effusion, reduced redness and pain</td>
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<tr>
<td></td>
<td></td>
<td><em>Stable:</em> Generally no effusion, minimal stiffness</td>
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<tr>
<td>Osteoarthritis (OA)</td>
<td>Cartilage (degradation)</td>
<td>Affects hips, knees, spine, ankles, distal interphalangeal (DIP) joints, proximal interphalangeal (PIP) joints, and metacarpophalangeal (MCP) joints</td>
<td>Osteophytes at joint margins, joint space narrowing, subchondral sclerosis and cysts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Joint pain, malalignment</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Decreased proprioception</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Muscle weakness</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td><em>Early:</em> Focal cartilaginous lesions</td>
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<td></td>
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<td><em>End stage:</em> Loss of cartilage, bone on bone</td>
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</tr>
</tbody>
</table>

Classic Radiographic Appearance of Primary Osteoarthritis

- Unequal joint space narrowing
- Eburnation (hard, white appearance) of subchondral bone
- Osteophyte formation
- Subchondral cysts

Table 28-2
Kellgren-Lawrence Classification of Radiological Joint Changes in Osteoarthritis

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 0</td>
<td>No features</td>
</tr>
<tr>
<td>Grade 1</td>
<td>Doubtful: Minute osteophyte, doubtful significance</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Minimal: Definite osteophyte, unimpaired joint space</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Moderate: Moderate diminution of joint space</td>
</tr>
<tr>
<td>Grade 4</td>
<td>Severe: Greatly impaired joint space with sclerosis of subchondral bone</td>
</tr>
</tbody>
</table>


Signs, Symptoms, and Impairments

**Joint Pain, Stiffness, Restricted Motion, and Alterations in Alignment**

Osteoarthritis causes pain, aching, or stiffness and eventually altered joint alignment. Cartilage does not have nerve endings; therefore the pain of OA may be caused by stretching of the joint capsule as a result of inflammation, the release of inflammatory cytokines in the synovial fluid, muscle spasms, and pressure on the subchondral bone. Patients frequently report that the pain increases with activity and is relieved by rest. Some patients have nighttime pain and report stiffness on waking. The stiffness often resolves in less than an hour and may be present after rest or with prolonged sitting.

Limitations in joint range of motion (ROM) are the result of osteophyte formation, soft tissue and tendon contractures surrounding a joint, periarticular muscle spasm, destruction of joint cartilage, persistent faulty posture, or muscular imbalance. Although a flexed position minimizes intra-articular pressure and reduces pain, it leads to flexion contracture. Crepitus may be felt when the joint is passively moved through the ROM; this results when irregular opposing cartilage surfaces rub together. Localized joint swelling is evident in patients with erosive OA and presents as warmth and soft tissue swelling.

With hip OA, pain may be present in the hip, groin, anterior thigh, knee, or buttocks. ROM often is restricted,
particularly internal rotation, and may be accompanied by crepitus. Patients may experience difficulties with mobility and personal hygiene, as well as increased energy expenditure with activities. Loss of hip range adversely affects the spine and other joints, including the knee and ankle. Preventive stretching is important and should be initiated early and often. Functionally based exercises, such as repetitive sit to stand, help maintain strength in hip and knee extensors. For patients unable to tolerate full gravity exercise, water (aquatic therapy) can be used to allow exercise with reduced load.8

**Signs and Symptoms of Osteoarthritis**

- Pain or aching with activity
- Morning stiffness
- Altered joint alignment
- Limited range of motion
- Joint contracture
- Crepitus
- Joint swelling

The knee is the most commonly affected weight-bearing joint. Malalignment of the knee, either varus or valgus, may be evident with severe disease (Figure 28-3). Knee varus is the more common presentation in knee osteoarthritis. The presence of varus or valgus is associated with a threefold to fourfold increase in the odds of OA progression in the medial compartment of the knee.2 Malalignment and abnormal tracking of the patella may produce retropatellar pain and chondromalacia patellae. Retropatellar pain often is experienced when the individual walks upstairs or on inclines or sits for prolonged periods. Knee pain can lead to disuse atrophy and deconditioning.2,10 However, one research study suggested that muscle weakness may be a cause rather than a result of knee osteoarthritis.11 Muscle weakness leads to changes in joint biomechanics and unequal forces across the joint surface. Joint laxity from muscle inhibition and joint space narrowing distributes the forces across the cartilage surface unequally and can accelerate the process of cartilage degeneration.8

Common features of hand OA are Heberden’s and/or Bouchard’s nodes, which are the result of bony overgrowths (Figure 28-4). Heberden’s nodes appear at the medial and dorsolateral aspects of the distal interphalangeal (DIP) joints, and Bouchard’s nodes appear at the proximal interphalangeal (PIP) joints. The finger joints appear bony and become less stable and less functional. Effusions may be present and over time lead to joint ankylosis. As a result of these deformities, patients lose their ability to grip small objects or to make a tight fist.

OA of the spine, also known as spondylosis, may affect the cervical, thoracic, and/or lumbar regions. Common changes evident on radiographs include osteophytes, which may form adjacent to the end plates and reduce blood supply to the vertebral; stiffening and sclerosis (thickening or hardening) of the bone; facet joint degeneration; and degeneration of the disc. Severe OA of the facet joints can lead to spinal stenosis. Limited range of motion, especially
rotation of the neck, is evident with cervical OA, along with pain and stiffness with movement.3

**Muscle Weakness**
Periarticular muscular weakness adds to the progression of disease through functional instability and diminished neuromuscular protective mechanisms.9 Disuse atrophy probably results from ligament stretching, reflex inhibition from pain, capsular contraction, and joint irritation caused by pain and effusion.8 Atrophy of the muscles because of reflex inhibition starts a vicious circle (Figure 28-5), increasing force across the damaged cartilage and altering the mechanics of the joint.

**Proprioceptive Deficits**
Proprioceptive changes occur with age,12 with sedentary lifestyles, and with joint instability. These factors may contribute to or result from osteoarthritis. Proprioception is necessary for appropriate spatial and temporal coordination of the limb during movement. This increased coordination enhances stability and leads to more normal load distribution, reducing the risk of injury. Changes in proprioception may result from destructive alterations in the ligaments, cartilage, capsule, or muscle and tendon that alter joint alignment.8 On examination, reduced joint proprioception may be present along with joint hypermobility. Barrett et al.13 demonstrated that individuals with knee osteoarthritis have poorer knee proprioception than their healthy older counterparts. In another study, 28 adults with unilateral knee osteoarthritis (Kellgren scale grade 2 or higher) and 29 adults without knee osteoarthritis were recruited to allow examination of the impact of OA on joint proprioception.14 A computer device and a stepper motor provided angular motion at 0.3°/sec and recorded angular displacement as patients reported the point at which they detected knee joint deflection. Patients with unilateral knee osteoarthritis demonstrated worse proprioception than their healthy counterparts.

**Basic Principles of Rehabilitation and Studies on the Effects of Exercise in Patients with Osteoarthritis**

**Goals of Rehabilitation and Studies on the Effects of Exercise**
The goals of rehabilitation in OA are to maximize function and muscle force production and to reduce the deconditioning associated with OA of the weight-bearing joints. Evaluations of regimens to correct or prevent contractures are almost nonexistent. Heat, followed by passive ROM exercises and joint mobilization, is used clinically to reduce contractures. Proper posture and positioning during extended inactivity or sleep, along with active ROM exercises, are used to maximize functional range and strength. In difficult cases, serial casting or splinting can reduce contracture when followed by maintenance exercises.

**Goals of Osteoarthritis Rehabilitation**

| • Maximize function |
| • Maximize strength |
| • Reduce deconditioning |

In a systematic review of exercise therapy for knee and hip osteoarthritis, van Baar et al.15 found that exercise interventions of varying modes yielded small reductions in disability, small to moderate effects on pain, and moderate effects of exercise on self-reported global assessments. Although studies have examined the impact of exercise on function, few investigators have examined the impact of strengthening programs on cartilage. Table 28-3 presents a summary of the various exercise studies designed for individuals with knee OA.

Few studies specifically measure changes in joint proprioception or the impact of exercise programs on joint proprioception. However, some studies emphasize the role of progressive balance activities (e.g., double-limb stance activities to single-limb stance) as methods of improving joint proprioception and strength, based on the assumption that proprioception does not spontaneously return when pain diminishes.16,17 A variety of exercises, such as standing on unsteady surfaces, using biomechanical ankle platform system (BAPS) boards, and tilt/rocker boards, are used for balance and proprioception training. Although the way that exercise influences proprioception is unclear, clinicians agree that addressing proprioception is important in the rehabilitation program.

In one small trial, patients with hand OA were instructed in yoga and relaxation techniques for 10 weeks. At the end of the trial, patients reported decreased pain and tenderness and improved motion of finger joints.18

Most studies on the effects of exercise focus on strengthening exercises for patients with mild to moderate OA.
### Table 28-3

**Randomized, Controlled Trials of Exercise in Hip and Knee Osteoarthritis**

<table>
<thead>
<tr>
<th>Author</th>
<th>Sample</th>
<th>Intervention/Groups</th>
<th>Duration</th>
<th>Study Outcomes</th>
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</thead>
<tbody>
<tr>
<td><strong>Studies That Included Aerobic Exercise</strong></td>
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<tr>
<td>Minor et al. (1989)</td>
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</table>
| 80 Patients with KOA 40 Patients with RA, mild to moderate disease                                    | 1. Stretching and isometric exercise 3 times/week for 1 hour plus aerobic walking, 30 minutes   | 12 weeks | Pool and walking programs increased aerobic capacity 20% and 19% respectively; control group had no change
No exacerbation of joint symptoms in the two aerobic groups
On average, pain decreased by almost 10% and morning stiffness by 20 minutes in aerobic groups
Physical activity, anxiety, and depression improved significantly in both aerobic groups more than for controls |
| Kovar et al. (1992)                                                                                                                                          |
| 102 Patients with chronic, stable KOA                                                                                                                       | 1. Supervised light stretching and strengthening plus education, followed by up to 30 minutes of walking
2. Control: Routine follow-up care, telephone follow-up calls 3 times/week                                                                               | 8 weeks  | Walking distance increased 18.4% in exercise group and decreased in control group
Exercisers reported 39% improvement in activity (WOMAC), 27% decrease in pain, and decreased use of medications |
| Ettinger et al. (1997)                                                                                                                                         |
| 459 Patients with radiographic evidence of KOA and disability                                      | 1. Aerobics for 60 minutes at 60% to 80% maximum HR
2. Resistive exercise
3. Education                                                                                                                                                | 18 months | 83% of participants completed the study
Adherence rate was 68% in aerobic group and 70% in strengthening group
Aerobic exercisers showed 10% decrease in disability, 12% less knee pain, and improved walk time, stair climbing, and carrying ability compared to controls
Strength group showed 8% decrease in disability and knee pain, improved walk time, stair climbing, and carrying ability compared to controls
No radiographic changes seen in any group |
| Bautch et al. (1997)                                                                                                                                         |
| 30 patients with KOA                                                                             | 1. Low resistance strengthening exercises, 3 times/week, 3 repetitions of each exercise, increased to 10 repetitions at 4 weeks plus low intensity treadmill walking plus education 1 time/week
2. Education only                                                                                                                                             | 12 weeks | Exercisers showed decreased pain levels
Educational only group demonstrated better AIMS scores
No change in synovial fluid composition |
| Messier et al. (2000)                                                                                                                                         |
| 103 Patients with KOA                                                                             | 1. Aerobic exercise for 50 minutes, 5-minute warm-up and cool-down, with 40 minutes of walking at 50% to 85% maximum HR, 3 times/week (3 months at center and 15 months at home) | 18 months | Both exercise groups improved compared to controls
Balance and postural sway improved in exercise groups |
Table 28-3
Randomized, Controlled Trials of Exercise in Hip and Knee Osteoarthritis—Cont’d

<table>
<thead>
<tr>
<th>Author</th>
<th>Sample</th>
<th>Intervention/Groups</th>
<th>Duration</th>
<th>Study Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2. Weight-training exercises for upper and lower extremities, 2 sets of 10 repetitions of each exercise, 3 times/week (3 months at center and 15 months at home) 3. Monthly education group sessions plus scheduled contact from research team</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penninx et al.³⁰ (2001)</td>
<td>250 Patients with KOA</td>
<td>1. Aerobic exercise, walking program 3 times/week for 60 minutes 2. Resistance exercises, 3 60-minute sessions per week using nine different exercises</td>
<td>3 months</td>
<td>Both exercise groups reduced their disability in ADLs as measured by a self-report questionnaire</td>
</tr>
<tr>
<td>Fransen et al.¹⁰⁷ (2001)</td>
<td>126 Patients with KOA; grades I, II</td>
<td>1. Individualized aerobic and strengthening led by the PT 2. Group aerobic and strengthening exercise, 2 times/week for 1 hour, supervised by a PT plus home exercise program 3. Wait list control</td>
<td>8 weeks</td>
<td>Both PT treatment groups showed significant improvements in pain, physical function, and health-related quality of life. Improvements were maintained for 2 months. No difference in outcomes was seen between the PT groups.</td>
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</tbody>
</table>

Studies of Strengthening, Flexibility and Other Interventions

<table>
<thead>
<tr>
<th>Author</th>
<th>Sample</th>
<th>Intervention/Groups</th>
<th>Duration</th>
<th>Study Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Callaghan et al.³¹ (1985)</td>
<td>27 Patients with KOA</td>
<td>1. PT-led exercises, 3 sets of 10 exercises, 4 times/week for 20 minutes 2. Education plus repeated sit to stand exercises, no intensity specified 3. Sham electrical stimulation</td>
<td>2 weeks</td>
<td>No differences were seen between groups on any outcome measures.</td>
</tr>
<tr>
<td>Borjesson et al.³² (1996)</td>
<td>68 Patients with medial KOA (scheduled for surgery); grades I-III</td>
<td>1. PT-led exercises, 40-minute session, 3 times/week; included warm-up for 10 minutes, knee flexion/extension with 1-3 kg (2.2-6.6 pounds) weight, toe and heel standing, and hip dynamic exercises; 2 sets of 10 repetitions for each exercise and isometrics using 10-second hold and stretches 2. Control</td>
<td>5 weeks</td>
<td>No significant differences in gait, ROM, or isokinetic strength were seen between groups. Patients in the PT group increased their ability to descend stairs and reported improved mood.</td>
</tr>
<tr>
<td>Schilke et al.¹⁰⁸ (1996)</td>
<td>20 Patients with KOA</td>
<td>1. Isokinetic exercise, 6 sets of 5 MVCs of knee flexors and extensors 2. Control: No prescription</td>
<td>8 weeks</td>
<td>Significant decrease in pain, stiffness, and AIMS activity and OASI scores. Increased mobility in the exercise group. Control group increased right knee flexion and left knee extension.</td>
</tr>
<tr>
<td>Author</td>
<td>Sample</td>
<td>Intervention/Groups</td>
<td>Duration</td>
<td>Study Outcomes</td>
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<tr>
<td>Van Baar et al. 33</td>
<td>201 Patients with HOA or KOA</td>
<td>1. Individual exercises 1-3 times/week for 30 minutes 2. Education</td>
<td>12 weeks</td>
<td>Exercisers showed 17-point decrease in pain and 19-point reduction in disability (effect sizes were medium to small, respectively)</td>
</tr>
</tbody>
</table>
| Rogind et al. 22         | 25 Patients with KOA (Kellgren grade 3 on radiograph) | 1. PT-led outpatient exercise, including general fitness, balance, coordination, flexibility, and strengthening exercises, 2 times/week 2. Control                                                                 | 12 weeks | 78% Adherence  
Exercise group increased quadriceps strength by 20%  
At 1 year, walking speed improved by 13%, decreased 3.8 points, pain reduced by 2 points  
Increase in palpable effusions   |
| O’Reilly et al. 109      | 191 Patients with KOA symptomatic | 1. Home exercises, including isometric knee exercise (5-second hold), dynamic knee and stepping exercises performed daily 2. Control                                                                                       | 6 months | Decrease in WOMAC pain score by 22.5% and by 6.2% in controls  
Significant improvement in VAS pain and 17.4% change in function among exercisers  |
| Deyle et al. 110         | 83 Patients with KOA, grades I, III | 1. Manual therapy to the knee, spine, hip, and ankle plus dynamic exercises for the hip and knee, as well as stretching exercise, 2 times/week for 30 minutes, plus a home exercise program 2. Subtherapeutic ultrasound | 4 weeks  | At 4 and 8 weeks, significant improvements in exercisers for 6MWT and WOMAC scores  
At 8 weeks, 6MWT improved 13.1% and WOMAC improved 55.8% compared to controls  
Gains still evident at 1 year  |
| Hopman-Rock and Westhoff  | 103 Patients with HOA or KOA   | 1. Peer-led educational program lasting 1 hour, plus 1 hour of PT-led dynamic and static exercises for the hip and knee, 1 time/week 2. Control                                                                                | 6 weeks  | Significant improvements in pain, quadriceps strength, knowledge, and self-efficacy at postassessment  
Benefits still evident at 6 months in exercise group  |
| Petrella and Bartha 19   | 179 Patients with KOA, mild to moderate (medial compartment) | 1. Progressive home-based exercise. Simple ROM and resistance exercises plus oxaprozin 2. Oxaprozin alone                                                                                                                                 | 8 weeks  | Improvement seen in activity (self-paced walking, stepping) and activity-related pain in both exercise groups  |
| Baker et al. 111         | 46 Patients with KOA           | 1. Progressive strength training program (squats, step-ups, isotonic exercises of the lower limbs)                                                                                                                                 | 16 weeks | Improvements seen in strength, pain, physical function, and quality of life  |
| Quilty et al. 112        | 87 Patients                     | 1. Nine 20-minute PT sessions, including quadriiceps exercises, postural exercises and education, functional exercises, footwear recommendations, and patellar taping. Exercises performed at home, 10 times/day 2. Usual care | 10 weeks | At 5 months, treatment group showed small decrease in pain and significant improvement in quadriceps strength  
No difference at 1 year  |
In Table 28-3, randomized, controlled trials of exercise for hip and knee osteoarthritis are described. In an innovative study by Petrella and Bartha, patients with knee OA were randomized to either a progressive resistive exercise program using common household items and nonsteroidal anti-inflammatory drugs (NSAIDs), or a progressive resistive exercise program using common household items combined with simple ROM exercises and NSAIDs. At the end of 8 weeks, patients in both exercise groups reported improvements in pain and functional performance compared to the group that received NSAIDs alone.

Table 28-3: Randomized, Controlled Trials of Exercise in Hip and Knee Osteoarthritis—Cont’d

<table>
<thead>
<tr>
<th>Author</th>
<th>Sample</th>
<th>Intervention/Groups</th>
<th>Duration</th>
<th>Study Outcomes</th>
</tr>
</thead>
</table>
| Foley et al. 20 (2003) | 105 Patients over age 50 with hip OA or KOA | 1. Hydrotherapy, 3 times/week  
2. Gym exercise, 3 times/week  
3. Control | 6 weeks | Both exercise programs produced functional gains and improved quadriceps strength compared with the control group  
Compliance was similar for the two exercise groups  
Hydrotherapy group had increased their distance walked compared to control group  
Gym exercise group showed increased walking speed and self-efficacy compared to control group |
| Gur et al. 34 (2002) | 23 Patients with bilateral KOA, grade II or III | 1. 12 Concentric knee exercises performed 3 times/week  
2. 6 Repetitions of concentric and 6 repetitions of eccentric knee exercises, at angular velocities of 30°-180°/sec  
3. Control: Usual activity | 8 weeks | Both exercise groups improved functional capacity, peak torque of knee, and pain relief  
Concentric-eccentric group performed better on the stair climbing/descending than the concentric group, and the concentric-eccentric group showed more reduction in pain  
Usual activity group did not show any improvements |
| Topp et al. 35 (2002) | 1. Dynamic resistance Thera-Band exercises for 40 minutes (10-minute warm-up and cool-down), 3 times/week  
2. Isometric exercises, 3 times/week | 16 weeks | Isometric group decreased their time to perform functional tasks by 16% to 23%  
A 13% to 17% decrease in time to ascend/descend stairs was seen in the dynamic group  
Pain decreased in both groups  
No change was seen in controls |
2. Active exercises for the hip (nine sessions) plus home program with weights, endurance training, ROM, and stretching | 5 weeks | An 81% improvement was seen in the manual therapy group compared to a 50% improvement in the exercisers |

KOA, Knee osteoarthritis; HOA, hip osteoarthritis; RA, rheumatoid arthritis; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; AIMS, Arthritis Impact Measurement Scale; HR, heart rate; MVC, maximum voluntary contraction; ADLs, activities of daily living; PT, physical therapist; OASI, Osteoarthritis Screening Index; ROM, range of motion; VAS, Visual Analogue Scale; 6MWT, 6-Minute Walk Test.
show greater gains in aerobic qualities of function, such as distance walked, whereas the gym-based group showed greater self-efficacy (i.e., confidence in self-management).

Hopman-Rock and Westhoff\textsuperscript{21} randomized 103 patients with hip and knee OA to a program of health education and exercise. The program lasted 6 weeks and consisted of weekly sessions lasting 2 hours. The sessions included 1 hour of education and self-management led by a peer and 1 hour of exercise led by a physical therapist. The exercise program included a 15-minute discussion of the pros and cons of exercise and the importance of rest and alternating activities; this was followed by a warm-up, static and dynamic strengthening exercises for the hip and knee, and a cool-down. Patients not allocated to the education and exercise group received usual care. Significant improvements were found for pain, quality of life, quadriceps strength, knowledge, self-efficacy, and a physically active lifestyle in the intervention group. The effects were present, although to a lesser degree, at the 6-month assessment.

Rogind et al.\textsuperscript{22} found positive outcomes in patients with severe knee OA who combined strengthening exercises and balance and coordination activities.\textsuperscript{22} In this trial, 25 subjects were allocated to a 3-month training program that consisted of general fitness exercises, balance and coordination activities, stretching, and lower extremity strengthening plus a home program at an outpatient clinic, or control. Subjects exercised in groups twice a week. At the 3-month assessment, quadriceps strength had increased 20%, as measured by isokinetic testing. At 1 year, improvements were found in pain (a reduction of two points) and in functional index scores (a 3.8 reduction) compared to controls.

Few randomized, controlled studies have examined the impact of manual mobilization techniques combined with exercise in patients with OA. Hoeksma et al.\textsuperscript{23} allocated 109 patients with hip OA to 5 weeks of either manual therapy and manipulations or active resistive hip exercises plus endurance training, ROM, and stretching. At the end of the trial, the manual therapy group demonstrated an 81% improvement compared with a 50% improvement in the exercise and stretching group.

Aerobic walking at moderate intensity appears to improve aerobic capacity by up to 20% without exacerbation of symptoms. In studies by Minor et al.\textsuperscript{24} and Kovar et al.,\textsuperscript{25} patients with mild to moderate osteoarthritis of the hips and knees not only improved aerobic capacity but demonstrated improvements in mood when aerobic walking was coupled with supervised stretching and strengthening exercises.

Ettinger et al.\textsuperscript{26} studied the effects of exercise in a less controlled setting. In this study, 439 community dwelling subjects age 60 or older who had radiographic hallmarks of knee OA, pain, and physical disability were randomly allocated to an aerobic exercise program at 60% to 80% maximum heart rate, a resistance exercise program, or a health education program. At 18 months, patients in the aerobic and resistance exercise groups demonstrated modest improvements in pain (12%) and disability (10%), and better scores on timed walk, stair climbing, and carrying ability than those in the health education group. The authors noted that education alone produced small improvements in outcomes, and this change may have led to the small differences between groups. Previous exercise behavior was the strongest predictor of exercise compliance in this sample.\textsuperscript{27}

In a similarly designed study, Messier et al.\textsuperscript{28} showed that aerobic exercise and strengthening programs improved balance and postural control. They enrolled 103 patients with knee osteoarthritis in an 18-month trial and allocated them to one of three groups: (1) supervised aerobic exercise at 50% to 85% of the maximum heart rate for 50 minutes, 3 times a week, for 3 months, followed by a home prescription; (2) supervised upper and lower extremity weight-training, 2 sets of 10 repetitions, 3 times a week, for 3 months, followed by a home exercise prescription; or (3) monthly educational sessions and scheduled contacts from the research team. At the end of the trial, patients in the exercise groups showed improved balance and postural stability.

**Conclusions about Exercise and Osteoarthritis**

The evidence from the preceding studies and others demonstrates that patients with mild to moderate knee and hip osteoarthritis can safely engage in effective aerobic and strengthening exercise without exacerbating joint symptoms. Improvements in mood, strength, and aerobic capacity are found, ranging from 15% to 40%, depending on the intensity of the prescribed exercise.\textsuperscript{8} Gains in functional performance and reductions in limitations are greatest when the program lasts at least 8 weeks and exercises are performed at least 3 times a week.\textsuperscript{20,24,25,28-35} As with other populations, compliance with an exercise program is critical to its effectiveness for the arthritic patient. Efficacy can be improved when home exercise is supplemented with a supervised program.

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**Clinical Point**

Few studies have addressed the impact of resistance or aerobic exercise on patients with severe osteoarthritis, and the long-term effects of exercise on joint integrity and disability are unknown.

Aerobic exercise improves endurance, reduces fatigue, and has modest effects on muscle strength. With structured exercise (3 times a week over 4 months), individuals can improve strength and endurance, leading to decreased dependency and pain and increased functional activity. Some of these benefits continue for up to 8 months after an intense program.\textsuperscript{36} The role of aerobic exercise in the management of patients with OA, particularly of the hips and knees, has received greater attention over the past 10 years. The concept that inactivity is a risk factor for osteoarthritis, rather than just an outcome of the disease,
emphasizes the importance of aerobic exercise in disease management.

**Achieving a Therapeutic Effect with Exercise.**

Some evidence indicates that exercises that focus on proprioception and balance may reduce disability and improve strength. However, more research is needed in this area. Despite the evidence that symptoms of OA of the hip and knee can be improved with exercise and that exercise is recommended in practice guidelines, most patients with OA have not had a prescription for exercise. Even when physicians prescribe exercise, only a small percentage of patients exercise in a manner that can achieve a therapeutic effect.\(^37\) Certain patients with osteoarthritis of the hip can exercise at home as effectively as with outpatient hydrotherapy to improve joint mobility and increase muscle strength.\(^38\) Including manual therapy with the exercise programs appears to provide added benefits. Caution needs to be applied in patients with lax or malaligned knees, especially with tibiofemoral OA, in which quadriceps strengthening may exacerbate symptoms. Table 28-4 summarizes the exercise recommendations for OA based on pain level and pathology.

**Gait Problems and Use of Assistive Devices**

A flexion contracture across the acetabulum toward the lateral margin\(^39\) increases valgus forces at the knee and ankle and causes inefficient gait patterns and increased energy expenditure. Patients describe difficulty and pain when walking or climbing stairs and reduced functional independence. Decreased muscle strength and reduced joint proprioception also are associated with an increased incidence of falls.\(^17\)

In one study, an exercise program consisting of individualized progressive training, including isometric and dynamic exercises for patients with knee osteoarthritis, significantly improved muscle function, functional capacity, and walking time (as much as 21%) and reduced self-reported difficulty with walking and pain.\(^36\) Stationary cycling also has demonstrated improvements in walking speed, aerobic capacity, and pain.\(^40\)

In a study by Leivseth et al.,\(^31\) six patients with severe OA of the hip who were awaiting total hip arthroplasty (THA) increased hip adduction by 8.3°, increased the type I and II fiber cross-sectional area, and increased glycogen levels after passive muscle stretching perpendicular to the direction of

<table>
<thead>
<tr>
<th>Type of Osteoarthritis (OA)</th>
<th>Recommendations</th>
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<tbody>
<tr>
<td>OA of the hip and knee</td>
<td></td>
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</tbody>
</table>
| Mild pain                  | AROM exercises (10 repetitions), 3 to 5 repetitions of flexibility and static exercises (8 to 10 repetitions of 6 seconds’ duration)  
Dynamic exercises, especially of the quadriceps and hamstrings (8 to 10 repetitions)  
Low impact aerobic activities (pool, bicycling) 20 minutes, 3 times/week  
Balance activities (BAPS and tilt boards), single-limb stance |
| Moderate pain              | Static and dynamic exercises—reduce to 5 repetitions.  
Flexibility exercises, 3 to 5 repetitions  
Low impact aerobic exercises (pool, bicycling) for 20 minutes, 3 times/week  
Balance and proprioception activities—bilateral  
Use of cane or lateral heel wedge foot orthosis, neoprene knee sleeve |
| Severe pain                | Static and dynamic exercises (no resistance), 3 to 5 repetitions except with internal joint derangement  
Low to no impact aerobic exercises (pool)  
Note: Advise functional activities to keep moving |
| Bone on bone               | Same as for severe form but few or no repetitions of dynamic exercises; patient education is very important  
Note: Caution should be used in prescribing quadriceps strengthening exercises for patients with ligamentous laxity and malalignment  
Orthosis: Varus unloader–type knee orthosis; may need crutches or walker |
| OA of the hand             | Active movements, few repetitions, low resistance  
Teach home exercises, which the patient should repeat daily  
Aim to maintain full range of motion of MCP, PIP, and DIP joints |


AROM, Active range of motion; BAPS, biomechanical ankle platform system; MCP, metacarpophalangeal; PIP, proximal interphalangeal; DIP, distal interphalangeal.
the adductor muscle (without hip movement). The subjects stretched with a force of 20 to 30 kg (44.1 to 66.1 lbs) applied manually for 30 seconds, rested for 10 seconds, and repeated; the sessions lasted 25 minutes and were performed 5 days a week for 4 weeks. Recent studies have also demonstrated improved rates of recovery in patients with end stage hip arthritis after preoperative and perioperative exercise programs for THA.

Gait problems are common in patients with OA of any of the weight-bearing joints and are a clue to underlying pathology of the soft tissues or the joints themselves. Left untreated, they can cause problems. Clinicians should be attentive this diagnosis and design treatments that maximize joint function.

Orthoses for Osteoarthritis

Much of the research into bracing for OA has concentrated on devices to relieve knee pain and disability. In OA, the knee is subjected to increased medial compartment pressures secondary to varus loading during gait. Two main methods have been advanced to reduce these excessive forces: unloader-type knee orthoses (KO) or lateral wedge insoles at the foot. An unloader KO for varus gonarthrosis, or knee varus, can be either a thrust-type (Figure 28-6) or prestressed brace. The thrust-type, hinged KO has a single upright designed to create a valgus correcting force at the knee to unload the medial compartment. Kirkley et al. compared use of a varus unloader KO to a neoprene sleeve or to medical treatment alone in a group of 119 subjects with OA. After 6 months, the subjects who wore the unloader KO showed a significant difference in pain relief with functional tasks (e.g., a 6-minute walk and a 3-minute stair climb) compared to the group who wore the neoprene sleeve. Both groups performed better than the nonbrace group.

Lindenfeld et al. assessed the biomechanical properties of the brace to actually reduce the varus forces as well pain. They compared 11 subjects with OA before and after 4 weeks of brace wear and then compared them to 11 healthy controls. As measured on the Cincinnati Knee Rating System, pain, function, and biomechanical alignment all improved in the brace group. Alignment levels were reported to approach that of the normal control group.

Lateral wedge insoles or a variant, subtalar strapped insoles, are prescribed to make use of the closed chain properties of a foot orthosis (FO) on reducing compressive forces on the medial tibiofemoral joint compartment. Brouwer et al. concluded that some limited evidence indicated that lateral wedges reduced the use of pain medication by OA patients when compared those who wore a neutral insole. However, function, as measured by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) functional scale, was not improved over the group that used neutral insoles after 6 months of wear. These researchers also reported that a lateral wedge insole with strapping for the subtalar joint demonstrated a biomechanical realignment effect, as measured by the femorotibial angle (FTA), but that those wearing these insoles reported more low back and foot pain with use. As yet, no studies have directly compared the use of an unloader KO with a lateral wedge insole or strapped subtalar lateral wedge insole. The clinical decision for use of these devices should be based on the patient’s degree of disability and potential for compliance with an orthosis and the cost of the device.

Case Study in Osteoarthritis

John is a 77-year-old male who presents with a diagnosis of right hip OA. His radiographic findings suggest decreased joint space with small acetabular osteophytes off the anterior aspect of the joint. He has opted to delay surgical intervention and wants to use physical therapy to enhance his overall physical status. He reports minimal difficulty with activities of daily living (ADLs) and instrumental activities of daily living (IADLs) (see volume 1 of this series, Orthopedic Physical Assessment, Chapter 1). However, he has been increasingly sedentary since retiring from the post office 10 years ago. Currently, he reports late afternoon soreness on the anterior aspect of the leg and along the groin to his medial thigh, especially after doing a lot of walking.

On examination, John walks with a slow, deliberate gait pattern. He demonstrates decreased stance time on the right leg, and his right hip is maintained in flexion throughout the gait cycle. Decreased step length is noted on the left, and a positive Trendelenburg’s sign on the right. Right hip ROM is 20° to 100° with a firm, unyielding end feel; internal rotation and abduction is 0° to 20° with a firm end feel; and external rotation is 0° to 35°. Left hip ROM...
Rheumatoid Arthritis

Case Discussion

The patient’s impairments of decreased hip muscle flexibility, poor muscle performance of the hip and trunk, poor motor control, pain, joint mobility, and diminished proprioception contribute to his altered gait and should be addressed in the rehabilitation program. Flexibility exercises and joint mobilization will help restore mobility and unload the hip joint while allowing a more normal gait pattern. Depending on the degree of pain, short-term use of a straight cane can further unload the joint for long distance walking. He will benefit from an exercise program that emphasizes strengthening of the proximal musculature of the hip, especially the weak gluteus medius. An exercise program should be started that incorporates stability exercises in weight bearing, such as rhythmic stabilization in standing, and progresses to unilateral static and dynamic control. The progression should take place as pain diminishes and proximal motor control improves. These activities not only improve motor coordination and strength, but also enhance proprioception. Aerobic exercise, such as aquatic classes and/or elliptical training, performed at 60% to 80% of his maximum heart rate, 3 times per week, should be incorporated into his program. The patient needs to learn how to modify his exercise regimen to adjust for his level of pain and to progress his exercises over time.

Rheumatoid Arthritis

Epidemiology and Pathophysiology

Classic rheumatoid arthritis is a chronic inflammatory disorder that not only affects joints, but also has multiple systemic manifestations. It affects approximately 1% to 2% of the U.S. population, and it shortens life expectancy by about 10 years. RA begins in early to middle life, affects women more often than men and the incidence increases with age.

The predominant pathology in rheumatoid disease is an inflammation of the synovium of diarthrodial joints, leading to a state of chronic synovitis. Synovitis that goes uncontrolled can lead to joint destruction (see Table 28.1). RA is characterized by periods of exacerbation and remission. The chronic fluctuating course of RA can follow various patterns. Patients may experience a continuous, low grade exacerbation or have periods of remission followed by exacerbations of various intensities. Although exacerbations are a feature of the disease, they can be triggered by infection or trauma or can occur after medications have been stopped. Fewer than 10% of patients with RA go into prolonged remissions.

The pattern of joint involvement generally is symmetrical and polyarticular. Nearly 10% of those affected develop some joint deformities within 2 years of diagnosis. Radiological changes often are seen earliest in the feet and hands. The Sharp score, as modified by van der Heijde, is a method of documenting the progression of the disease. Radiologists score the number of bony erosions and areas of joint space narrowing in 30 to 32 joints of the hand and 12 joints in the feet. The total score is recorded (maximum involvement equals 448 points) and monitored on successive radiographs to track progression.

Although RA can affect any area, the most commonly affected joints are the wrists, metacarpophalangeal (MCP) joints, and PIP joints in the upper extremity (Figure 28-7) and the ankle and foot (Figure 28-8) in the lower extremity. In the spine, RA is more common in the cervical area but can involve all segments. Because this is a systemic disease, extra-articular clinical symptoms may involve the cardiovascular system, pulmonary system, integument, and nervous system. Pleurisy, often presenting as shortness of breath or dyspnea on exertion, has been found in up to 70% of patients with RA. Pericarditis, myocarditis, and vasculitis, which may affect about 30% of patients, as well as renal effects secondary to vasculitis or to the toxic effects of long-term drugs used to control the disease, are all conditions that affect the physical functioning and exercise tolerance of patients with RA.
A, Ulnar deviation at the metacarpophalangeal (MCP) joints. This is a common deformity in patients with inflammatory arthritis, such as this patient with rheumatoid arthritis (RA). B, Ulnar deviation in rheumatoid arthritis. Severe ulnar deviation can be seen at the MCP joints with extensive erosions. Pancompartmental bony ankylosis and erosion are also seen at the wrist. C, Rheumatoid arthritis of the hand, showing advanced changes with ulnar drift and palmar subluxation at the MCP joints and swan neck and boutonniere deformities in the fingers. (A and B from Harris ED, Budd RC, Firestein GS et al: *Kelley's textbook of rheumatology*, ed 7, pp 491, 745, Philadelphia, 2005, WB Saunders; C from Swanson AB: Pathomechanics of deformities in the hand and wrist. In Hunter J, Schneider LH, Mackin EJ, Callahan AD, editors: *Rehabilitation of the hand: surgery and therapy*, p 895, St Louis, 1990, Mosby.)
Bone loss leading to osteoporosis is greater than in age-matched cohorts\(^5^3,5^4\) for both men and women with RA. In addition to the risk factors normally seen with primary osteoporosis, individuals with RA have factors such as periods of immobilization and long-term use of corticosteroids and disease-modifying antirheumatic drugs (DMARDs) (see volume 2 of this series, *Scientific Foundations and Principles of Practice in Musculoskeletal Rehabilitation*, Chapter 12). Studies have shown that patients with RA have a 1.5 to 3 times greater risk of osteoporotic fractures at the hip.\(^5^5,5^6\) Vertebral deformities caused by osteoporotic fractures are 2 to 3 times more prevalent in those with RA.\(^5^7\) However, a recent study by Haugeberg et al.\(^5^8\) indicated that even with the use of DMARDS and corticosteroids, bone loss can be mitigated in a patient with RA if the individual is treated with antiresorptive drugs, calcium, and vitamin D.

Another common symptom of RA is fatigue, which may result from a combination of cytokine production, deconditioning from lack of exercise or activity, and altered biomechanics of involved joints. As with other chronic diseases, the patient has a higher risk of depression, which may contribute to the fatigue. In addition, the systemic nature of RA and the increased metabolic cost of normal living may significantly limit a person’s function and restrict the level of independence as the disease progresses. The American College of Rheumatology has recommended a system to help clinicians classify the effect of the multiple impairments on the patient’s global functional capacity (Table 28-5).\(^5^9\)

### Table 28-5
American College of Rheumatology’s Classification of Global Functional Status in Rheumatoid Arthritis

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
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<tbody>
<tr>
<td>Class I</td>
<td>Completely able to perform usual activities of daily living (self-care, vocational, and avocational*)</td>
</tr>
<tr>
<td>Class II</td>
<td>Able to perform usual self-care and vocational activities but limited in avocational activities</td>
</tr>
<tr>
<td>Class III</td>
<td>Able to perform usual self-care activities but limited in vocational or avocational activities</td>
</tr>
<tr>
<td>Class IV</td>
<td>Limited in ability to perform usual self-care, vocational, and avocational activities</td>
</tr>
</tbody>
</table>

*Self-care activities include dressing, feeding, bathing, grooming, and toileting; avocational activities (recreational and/or leisure activities) and vocational activities (work, school, homemaking) are patient desired and age and gender specific.
RA may also affect children. Juvenile rheumatoid arthritis (JRA) (referred to as juvenile idiopathic arthritis [JIA] by the European League Against Rheumatism) is diagnosed when the onset of symptoms occurs before age 16 and the symptoms persist for at least 6 consecutive weeks. No specific diagnostic tests can be used to confirm JRA; rather, several tests can be performed to support the clinical impression of the disease. The three primary subtypes of JRA established by the American College of Rheumatology are pauciarticular JRA, polyarticular JRA, and systemic JRA. These subtypes are based on the number of joints involved, the presence or absence of systemic features and, in some cases, the age of onset.60 Because these classifications are based on the characteristics of the disease at onset, they may not indicate its course over time.61

Pauciarticular JRA is defined as synovitis in four or fewer joints, usually the elbows, knees, and ankles. The arthritis, which most often is asymmetrical, presents in the absence of systemic features. In pauciarticular JRA, the rheumatoid factor usually is negative. Pauciarticular JRA has two subtypes, based on the onset of disease and the clinical presentation. Early onset pauciarticular disease often occurs in girls before the age of 5. Late onset pauciarticular disease occurs around the ages of 10 to 12 years and most often affects the large weight-bearing joints (hips and knees) and entheses (muscle insertions). Stiffness and pain are the predominant complaints.61

Polyarticular JRA affects girls more often than boys. It is characterized by synovitis in five or more joints, and patients may present with systemic features of the disease. The synovitis often is symmetrical. Although polyarticular JRA may involve any joint, the cervical spine frequently is affected. It is important to note that polyarticular JRA affects normal growth and development.61

Systemic JRA can occur at any age and is gender neutral. It is characterized by high, spiking fevers, a classic rash (pink to salmon colored) that often occurs on the trunk and proximal extremities, and synovitis in one or more joints. The fever generally is the first symptom and may precede other symptoms by up to months. Malaise, anemia, pericarditis, thrombocytopenia, lymphadenopathy, hepatomegaly, and other systemic features evident with adult RA may be present. These children are so ill that they often present with severe functional limitations and growth retardation (below the 5th percentile).61

**Classification of Rheumatoid Arthritis in Children**

- Pauciarticular (four or fewer joints)
  - Early onset
  - Late onset
- Polyarticular (five or more joints)
- Systemic

**Signs, Symptoms, and Impairments**

**Pain, Stiffness, and Swelling**

RA can cause adaptive shortening of the soft tissues, tendons, and joint capsules. Bone erosion and cartilage loss reduce joint space and may contribute to subluxation-limiting joint motion. Swelling associated with joint effusion and extra-articular edema further reduces mobility. These changes result in significant mobility impairments and pain, especially during exacerbations. Analgesic and anti-inflammatory medications are the mainstays of medical management for these patients (see volume 2 of this series, *Scientific Foundations and Principles of Practice in Musculoskeletal Rehabilitation*, Chapter 12). However, physical modalities and exercise play an important role in reducing functional loss.

**Signs and Symptoms of Rheumatoid Arthritis**

- Chronic inflammation
- Exacerbations and remissions
- Symmetrical, polyarticular joint involvement
- Osteoporosis
- Fatigue
- Pain
- Deformity (subluxations)
- Mobility impairment
- Muscle weakness
- Depression

**Studies that Address Pain, Stiffness, and Swelling.** Cold helps reduce inflammation and pain when the joints are acutely inflamed. Heat should be avoided at this time, because it may exacerbate the inflammatory process.62 When the inflammation resolves, either heat or cold can be used to relieve pain.63 Local heat may be preferred before gentle exercise to reduce joint stiffness. In general, few studies examine the effectiveness of modalities in the management of RA. A recent Ottawa Panel64 concluded that some (but limited) evidence supports the use of ultrasound, paraffin, transcutaneous electrical nerve stimulation (TENS), and low level laser therapy in the management of pain and flexibility. The panel’s guideline further stated that evidence for including or excluding electrotherapy modalities is inconclusive at this time.

Exercise may be used to reduce joint pain and stiffness through the stimulation of endogenous opiates. Ek Dahl et al.65 studied endorphin levels in patients with RA during exercise. They showed that a rise in serum levels of these internal opiates is directly related to the intensity and frequency of active exercise. Numerous research studies have found that ROM exercises safely and efficiently maximize joint motion in patients with RA even when performed for long periods.66–70 Patients with early or stage I disease
can safely perform daily exercise, including active flexibility and ROM, doing a few repetitions at each joint. Passive stretching should be deferred until the joints are not in an active exacerbation.8

**Muscle Weakness**

Muscle weakness is common with RA. Compared to age-matched healthy individuals, individuals with RA are as much as 33% to 55% weaker in knee flexion and extension.62,71 The weakness is attributable to a number of causes, such as myositis or muscle fiber atrophy. Myositis, characterized by inflammation within the muscle itself, is not always apparent but can be assessed through muscle enzyme testing. If myositis is not present or is minimal, muscles can be exercised sufficiently so that training effects for muscle strengthening can be achieved.72 Atrophy has been shown to occur in both type I and type II muscle fibers and may stem either from disuse or from changes to the muscle tissue itself.73

**Studies of Strength Training.** Studies of strength training for patients with RA have focused on both effectiveness and safety.74-76 Early studies of strength training focused on the impact of low intensity training, such as active ROM, isometric, or low load resistance exercise programs.74 These studies incorporated exercise of varying intensity, frequency, and duration to avoid exacerbation of symptoms. More recent investigations studied moderate to high intensity strength training programs, defined as 50% or greater of maximum voluntary contraction (MVC). Considerable emphasis was placed on determining whether patients with RA could tolerate higher loads without sacrificing joint integrity. The randomized, controlled trials of exercise in patients with RA are reviewed in Table 28-6.75-82

<table>
<thead>
<tr>
<th>Table 28-6</th>
<th>Randomized, Controlled Trials of Exercise in Rheumatoid Arthritis</th>
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<tbody>
<tr>
<td><strong>Author</strong></td>
<td><strong>Sample</strong></td>
</tr>
<tr>
<td>Ekblom et al.113 (1975)</td>
<td>34 Patients with nonactive disease, class II, III</td>
</tr>
<tr>
<td>Ekblom et al.67 (1975)</td>
<td>30 Patients with nonactive disease, class II, III</td>
</tr>
<tr>
<td>Harkcom et al.84 (1985)</td>
<td>20 Patients with nonactive disease, class II</td>
</tr>
<tr>
<td>Minor et al.24 (1989)</td>
<td>40 Patients with variable disease activity</td>
</tr>
<tr>
<td>Author</td>
<td>Sample</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Baslund et al.¹¹⁴ (1993)</td>
<td>18 Patients with moderate disease activity</td>
</tr>
<tr>
<td>Hansen et al.¹¹⁵ (1993)</td>
<td>75 Patients with mixed disease activity, class I, II</td>
</tr>
<tr>
<td>Van den Ende et al.⁷⁰ (1996)</td>
<td>100 Patients with stable disease</td>
</tr>
<tr>
<td>Hall et al.⁸⁶ (1996)</td>
<td></td>
</tr>
<tr>
<td>van den Ende et al.⁸⁵ (2000)</td>
<td>64 Patients with active RA, no TKR, mean disease of 8 years, in hospital for care</td>
</tr>
<tr>
<td>Westby et al.¹¹⁶ (2000)</td>
<td>30 Women with class I, II disease; low dose steroids</td>
</tr>
</tbody>
</table>
Table 28-6
Randomized, Controlled Trials of Exercise in Rheumatoid Arthritis—Cont’d

<table>
<thead>
<tr>
<th>Author</th>
<th>Sample</th>
<th>Intervention/Groups</th>
<th>Duration</th>
<th>Study Outcomes</th>
</tr>
</thead>
</table>
| Bilberg et al.87 (2005)       | 46 Patients with class I, III disease; stable medications | 1. Group pool exercise, moderate intensity aerobic and strength exercise  
2. Home exercise                                      | 12 Weeks | Exercisers had a 21% reduction in ESR values versus a 13% increase in controls.  
Significant changes were seen in HAQ and fitness level  
No change was seen in bone density                           |
| Wessel and Quinney117 (1984)  | 32 Patients with stable disease, class II                  | 1. Isometric knee exercise, 3 times/week  
2. Isokinetic knee exercise, 3 times/week  
3. Control                                                 | 7 Weeks | Pain (both VAS and modified BORG scale) was significantly higher at all tests for isometric exercises than for isokinetic exercises at 180°/sec  
Swelling was not detected in any group                     |
| Ekdahl et al.65 (1990)        | 67 Patients with low to moderate disease activity, class II | Home exercises supervised PT visits four groups:  
1. Dynamic plus 12 PT visits  
2. Dynamic plus 4 PT visits  
3. Static exercise plus 12 PT  
4. Static plus 4 PT visits; HEP for additional 3 months | 6 Weeks | Dynamic exercisers had significantly greater increases in strength, aerobic capacity, endurance, and functional ability than static exercisers; effects persisted at 3 months  
No joint flares occurred in either group                   |
| Brighton et al.66 (1993)      | 44 Patients with class I disease                           | 1. Hand exercises daily  
2. No exercise or active disease                       | 48 Months| Significant increases were seen in strength and pinch grip in the exercisers  
Deterioration was noted in controls                        |
| Hoenig et al.118 (1993)       | 57 Patients with class II, III disease                    | All patients performed exercises 2 times/daily for 10 to 20 minutes  
1. Hand ROM exercises  
2. Hand resistance exercise  
3. Hand ROM plus resistive exercises  
4. Control                                                   | 3 Months | ROM improved hand joint count  
Resistance and dexterity improved                          |
| Hakkinen et al.77 (1994)      | 43 Patients                                                      | 1. Progressive dynamic strength training, 2 to 3 times/week at 40% to 60% max RM  
2. Habitual physical activity                             | 10 Months| Exercise group significantly improved bilateral dynamic strength (32%) and unilateral strength; ESR levels and function increased  
Only slight changes were seen in joints                     |
Table 28-6
Randomized, Controlled Trials of Exercise in Rheumatoid Arthritis—Cont’d

<table>
<thead>
<tr>
<th>Author</th>
<th>Sample</th>
<th>Intervention/Groups</th>
<th>Duration</th>
<th>Study Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stenstrom et al.</td>
<td>54 Patients with class I, II disease</td>
<td>Two groups: 1. Dynamic exercise, 3 times/week for 30 minutes 2. Relaxation training, 3 times/week for 30 minutes</td>
<td>3 Months</td>
<td>Dynamic group showed less perceived exertion with activity and improved scores on walking tasks. Relaxation group improved in health-related perception, had less joint tenderness, and better LE muscle function.</td>
</tr>
<tr>
<td>Rall et al.</td>
<td>30 Patients with controlled disease</td>
<td>Four groups: 1. 8 Healthy elderly adults 2. 8 Patients with RA 3. 8 Young, healthy patients who performed resistance exercises 2 to 3 times/week at 80% IRM 4. 6 Elderly adults who did warm-up swimming exercise</td>
<td>12 Weeks</td>
<td>Exercisers increased muscle strength compared to controls: RA, 57%; young exercisers, 44%; elderly exercisers, 35%; no change was seen in joint symptoms. No change was seen in joint symptoms. RA patients reported improvements in pain and fatigue.</td>
</tr>
<tr>
<td>Komatireddy</td>
<td>49 Patients with class II, III disease</td>
<td>1. Progressive resistive circuit exercises at 30% to 40% of maximum load, more than 3 times/week for 20 to 30 minutes, plus video 2. No exercise</td>
<td>12 Weeks</td>
<td>Exercisers had significant improvements in self-reported joint counts and number of painful joints, knee extension HAW scores, and sit to stand time. No significant changes were seen in VO2 max or treadmill time.</td>
</tr>
<tr>
<td>Stenstrom et al.</td>
<td>54 Patients with class I, II disease</td>
<td>Two groups: 1. Dynamic training 2. Relaxation exercises for 30 minutes 5 times/week for 3 months then 2 to 3 times/week for 9 months (total time is 1 year)</td>
<td>12 Months</td>
<td>Improved physical and work impact was seen among dynamic exercisers, as measured by AIMS2. Relaxation group reported less pain, emotion reaction. No significant differences were seen in health status or joint tenderness between the groups. Compliance was about 65% for both groups over 1 year.</td>
</tr>
<tr>
<td>Bostrom et al.</td>
<td>45 Patients with mild RA</td>
<td>1. Progressive dynamic shoulder exercises at 30% maximum load, 3 times/week for 40 to 60 minutes 2. Static shoulder exercises</td>
<td>10 Weeks</td>
<td>Both groups reported fewer UE swollen joints and less shoulder-arm pain. Dynamic exercisers showed improvements in physical and overall dimensions in the Sickness Impact Profile.</td>
</tr>
<tr>
<td>McMeeken et al.</td>
<td>36 Patients with nonacute RA</td>
<td>1. Knee extensor and flexor strengthening at 70% max RM, 2 to 3 times/week for 45 minutes 2. Attention control</td>
<td>6 Weeks</td>
<td>Exercisers reported significantly less pain and had improved knee extension/flexion strength and improved function as measured by HAQ and increased TUG time.</td>
</tr>
<tr>
<td>Author</td>
<td>Sample</td>
<td>Intervention/Groups</td>
<td>Duration</td>
<td>Study Outcomes</td>
</tr>
<tr>
<td>-------------------------------</td>
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<td>-------------------------------------------------------------------------------</td>
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<tr>
<td>Hakkinen et al.(^{123}) (1999)</td>
<td>67 Patients with recent onset disease (&lt;2 years)</td>
<td>1. Dynamic whole body exercises at 50% to 60% maximum load, 2 times/week for 45 minutes 2. ROM exercises 2 times/week and normal recreational activities</td>
<td>12 Months</td>
<td>Significant strength increases (22% to 35%) were seen in the dynamic group versus 3% to 24% in the ROM group. No significant changes were seen in BMD.</td>
</tr>
<tr>
<td>Hakkinen et al.(^{79}) (2001)</td>
<td>70 Patients with recent onset disease (&lt;2 years)</td>
<td>1. Dynamic whole body strengthening at 50% to 70% max RM, 2 times/week for 45 minutes 2. 2 times/week for 24 months; all patients were encouraged to participate in recreational activities 2 times/week</td>
<td>24 Months</td>
<td>62 Patients completed the study. Muscle strength disease activity (HAQ) and function improved in both groups, but greater improvements were seen in those who did dynamic exercises (19% to 59% increase in muscle strength). ROM group showed decreased BMD, whereas dynamic exercisers showed slight improvements in BMD femoral neck (0.51 ± 1.64%) and spine (1.17 ± 5.34%).</td>
</tr>
<tr>
<td>DeJong et al.(^{75}) (2003)</td>
<td>309 Patients with class I-III disease</td>
<td>1. High intensity bicycle, circuit exercises, sports 2. Usual care</td>
<td>2 Years</td>
<td>Significant improvements were seen in aerobic fitness, muscle endurance, and self-reported improved function (MACTAR); no significant effect was seen on the small joints of the hands and feet. No mean radiological changes were seen in the large joints except in those with baseline moderate changes.</td>
</tr>
<tr>
<td>Hakkinen et al.(^{81}) (2004)</td>
<td>70 Patients with recent onset disease (&lt;2 years)</td>
<td>5-Year follow-up study of above groups</td>
<td>24 Months, monitored by researchers; 36 months, self-monitored</td>
<td>59/62 Subjects were re-evaluated at 5 years. Gains in muscle strength in exercisers were maintained with self-monitored exercise. BMD values remained unchanged from 2-year status. Few joint changes were seen.</td>
</tr>
<tr>
<td>DeJong et al.(^{88}) (2004)</td>
<td>309 Patients with stable disease, class I-III</td>
<td>1. High intensity weight-bearing exercise 2. Usual care</td>
<td>2 Years</td>
<td>Exercise groups showed significant improvement in aerobic fitness and a decrease in radiological joint changes in the feet. Increase in BMD of the hips was seen in the weight-bearing group.</td>
</tr>
</tbody>
</table>

\(^{IRM}\), Illness Representation Model; \(^{AIMS2}\), Arthritis Impact Measurement Scale 2; \(^{BMD}\), bone mineral density; \(^{BORG}\), Borg scale of perceived exertion; \(^{ESR}\), erythrocyte sedimentation rate; \(^{HAQ}\), Health Assessment Questionnaire; \(^{HEP}\), home exercise program; \(^{HR}\), heart rate; \(^{LE}\), lower extremity; \(^{MACTAR}\), McMaster Toronto Arthritis Patient Preference Questionnaire; \(^{max RM}\), repetition maximum; \(^{MVC}\), maximum voluntary contraction; \(^{PT}\), physical therapist; \(^{RA}\), rheumatoid arthritis; \(^{rpm}\), revolutions/minute; \(^{SE}\), standard exercise; \(^{SF-36}\), McGill Pain Questionnaire and Short Form SF-36; \(^{TKR}\), total knee replacement; \(^{TUG}\), timed up and go test; \(^{UE}\), upper extremity; \(^{VAS}\), Visual Analogue Scale; \(^{VO2 max}\), maximum amount of oxygen in milliliters.
In the aggregate, studies show that both static and dynamic strengthening programs improve strength and function in patients with RA in the range of 15% to 50%. Most of the studies included exercise at a frequency of 2 to 3 times a week. Studies of low to moderate intensity (25% to 50% MVC) demonstrated improvements in strength of approximately 15% to 30%; those of higher intensity showed greater gains. For example, McMeekan et al.\(^8\) assigned 36 patients with nonactive RA either to a control group or to a group that performed knee flexor/extensor strengthening exercises at 70% MVC for 45 minutes, 2 to 3 times a week, for 6 weeks. At the 6-week follow-up, patients in the exercise group were able to generate significantly greater isokinetic torque than the control group. In addition, the exercise group reported less pain and greater function and mobility on a Health Assessment Questionnaire (HAQ).

Hakkinen et al.\(^8,0\) compared the effect of a home strength training program performed at 50% to 70% maximal repetitions for upper extremity (UE) and lower extremity (LE) muscle groups with a home program of ROM exercises; both groups exercised twice weekly. Both groups also performed an aerobic exercise program 3 times a week. Variables studied included knee extension and hand grip strength, bone mineral density (BMD) of the femoral neck and lumbar spine, and radiographic joint changes. At the 2-year point, 62 patients completed the program. The exercise group showed a significant difference in maximum strength on a dynamometer and little joint damage. BMD showed little or no change. The subjects continued the exercise program on a self-monitored basis for 3 years. At the end of 3 years (5 years total of exercise), 59 of the original 62 patients were evaluated again. Strength gains were maintained for the resistance-trained groups through the subsequent 3-year self-monitored phase. BMD was unchanged, and radiographic evidence of joint damage continued to be low.

**Fatigue and Endurance**

Studies demonstrate that patients with RA have decreased aerobic capacity compared to healthy subjects. This is the result of deconditioning secondary to inactivity and pain, as well as the direct effects of the disease on the cardiovascular or pulmonary systems. However, with short-term conditioning programs, physical function can increase and cardiovascular fitness can be improved by 20%, as measured by \(\text{VO}_2\text{max}\).\(^6,7,0\) The greatest improvements in aerobic capacity are gained with exercise regimens at 50% to 80% of \(\text{VO}_2\text{max}\).\(^8\)

Aerobic exercise programs for patients with RA should be designed to accommodate the patient’s functional limitations and degree of joint involvement. Non-impact-loading forms of land exercise, such as walking or cycling, should be considered to reduce stress to joints. Swimming and other aquatic exercise regimens have the advantage of using the buoyancy of water to reduce load. The recommended water temperature for patients with arthritis is 37\(^\circ\) to 40\(^\circ\)C (98.6\(^\circ\) to 104\(^\circ\)F), warm enough to help control pain and reduce muscle tension and joint stiffness.\(^7,2\)

**Studies of Aerobic Exercise.** Initial studies of aerobic exercise enrolled patients with nonactive disease and used bicycle ergometry as the mode of exercise. In the earlier trials, exercise prescriptions were maintained at a relatively low intensity. Harkcom et al.\(^8,4\) examined the impact of short burst (e.g., 15, 25, or 35 minutes), low intensity aerobic conditioning over 12 weeks. Only subjects assigned to the 35-minute low-intensity conditioning program demonstrated statistically significant improvements in aerobic capacity (6.9 mL/kg/minute, on average). Improvements among exercisers in the 25- and 15-minute programs were not statistically significant. All exercisers reported significant decreases in joint pain and swelling compared to nonexercising controls (p < 0.01).

Van Ende et al.\(^8,5\) studied 100 patients with RA in a 12-week program of high intensity exercise versus ROM and isometric exercises. The high intensity program included weight-bearing exercises and bicycling at 70% to 85% of the patient’s age-predicted maximum heart rate. The low intensity groups did ROM and static strengthening exercises for the trunk and lower extremity; or an individual low intensity ROM and static exercise program, with instruction from a physical therapist; or a written home program of ROM and static exercises. At the end of 12 weeks, those exercising at the higher intensities showed significant improvement in aerobic capacity and knee muscle strength and mobility. An important find was that no exacerbation of joint symptoms was seen in any group, and joint symptoms actually decreased among the high intensity exercisers. Muscle strength gains were maintained, but aerobic gains were lost at a follow-up 12 weeks after the program ended.

Research on alternative forms of aerobic exercise, such as aquatic programs, has shown mixed results. Minor et al.\(^24\) conducted a study of aerobic walking and aquatic programs that demonstrated improvements in both aerobic capacity and emotional satisfaction. Hall et al.\(^8,6\) evaluated the effect of 4 weeks of seated immersion hydrotherapy versus land exercises or relaxation training. Each group met twice a week for 30 minutes. Subjects in the hydrotherapy group reported 27% less joint tenderness and an improvement in total combined knee motion.

In a more recent study, Bilberg et al.\(^8,7\) assigned 46 subjects with class I to class III RA to either a treatment group, which participated in supervised aquatic therapy 2 times a week for 12 weeks, or to a control group, which continued with their regular activities. These authors found no significant aerobic effect from water exercise, as measured by cycle ergometry. However, they did report improved muscle endurance for both UE and LE muscle groups, as measured by isometric grip strength and a functional chair rise test.
Articular Changes

The effect of moderate to high intensity exercise on joint integrity has been a major focus of recent research. De Jong et al. reported on a series of recent studies in which patients with stable class I to class III RA who participated in these higher levels of exercise were monitored over 2 years. In one study, 309 patients with stable RA who were enrolled in the Rheumatoid Arthritis Patients in Training (RAPIT) program were randomly assigned either to a usual care group or to an intensive supervised exercise group. The exercise group met for 75 minutes, 2 times a week, for 2 years. The exercise program was threefold: bicycle aerobic training for 20 minutes, a 20-minute exercise circuit consisting of 8 to 10 exercises, and a sport or game for 20 minutes. The exercise session also included warm-up and cool-down periods. Impact loading for joints included jumping during the warm-up and the selection of sports such as basketball, volleyball, indoor soccer, and badminton; 281 subjects finished the study.

The researchers assessed the effect of high intensity impact-generating exercise on the small joints of the feet and hands of 136 participants; 145 subjects had usual care. After 2 years, these researchers found that, not only did the rate of joint changes for the small joints not increase, but that the exercisers’ feet showed less progression. In the larger weight-bearing joints (i.e., the knee and hip), the mean radiographic change was not significant for the whole group. However, participants who began the study with more radiological evidence of changes in the larger weight-bearing joints did show a progression of changes. The researchers also reported improved aerobic capacity for the exercise group.

These studies suggest caution in prescribing exercise to patients who already have significant joint damage, especially in the large weight-bearing joints; however, they also support the use of such exercise in the small joints of the hands and feet.

Basic Principles of Rehabilitation and Studies on the Effects of Exercise in Patients with Rheumatoid Arthritis

The goals of rehabilitation in the management of RA are to maximize strength, flexibility, endurance, and mobility and to promote independence while minimizing the potential for further joint destruction and deformity. A well-designed intervention program incorporates information about the extent of the joint impairments, as well as the patient’s stage of disease, motivation, and adherence to therapy. It is important to consider the patient’s psychological state and motivation for rehabilitation. Depression and reduced self-efficacy are common in a chronic disease such as RA. Interventions used in the management of RA include various forms of exercise, orthoses, adapted ambulatory aids, modalities, and patient education in energy conservation techniques.

Physical activity levels are low in patients with RA. A recent study on physical fitness and health perceptions of individuals with RA indicated that 47% of 298 participants reported low to fair levels of activity on a regular basis. Patients with a chronic disease such as RA have to incorporate exercise and rehabilitation techniques into their daily lives; this makes adherence more difficult. In a recent trial by Munneke et al. that examined exercise adherence in 146 patients with RA, 81% of the participants were still engaged in the supervised exercise program after 2 years. Patients with high disease activity and low functional ability at baseline were slightly more likely to drop out of the trial. However, strategies can be used to enhance adherence. Iversen et al. found that a positive social support system can improve the adherence rate by 300%. It also is important to recognize the impact of the clinicians’ own beliefs and expectations on the patient’s adherence to therapy. Provider expectations and beliefs about various modes of exercise have been shown to affect patient adherence to exercise prescriptions.

Rehabilitation Goals for Rheumatoid Arthritis

- Maximize strength
- Maximize flexibility and mobility
- Maximize endurance
- Promote independence
- Minimize deformity and joint destruction

Summary of Exercise Recommendations for the Patient with Rheumatoid Arthritis

Exercise should be considered an important, lifelong component of the management of rheumatoid arthritis. It has been shown to improve mobility, strength, endurance, function for daily tasks, and mood in patients with RA. Table 28-7 summarizes the exercise recommendations at various levels of disease presentation for RA. Daily ROM exercises should be performed on affected joints to maintain mobility and prevent contractions. During an exacerbation, 2 to 3 repetitions of active range of motion (AROM) exercises can be performed without unduly stressing the joints. Byers recommends that patients exercise in the evening to help reduce the morning stiffness associated with RA. When the disease is in remission, ROM exercises can be increased to 8 to 10 repetitions a day for each involved joint.

Strengthening programs can incorporate isometric or active exercises with resistance when the patient is not experiencing an active flare-up (also called a flare), or exacerbation. Isometric exercise generally results in less inflammation, less of an increase in intra-articular pressure, and less shear. The clinician must keep in mind, however, that sustained exercises of large muscle groups may put an increased load on the cardiovascular system and may be contraindicated in patients with RA who have cardiac problems.

Clearly, aerobic exercise programs, including those with weight-bearing components, appear to be better tolerated.
than previously thought, at least in patients with stable disease (i.e., disease that is not in a period of active flare-up). The effect of more intensive exercise on patients with a more aggressive disease process is not yet clear, but the most recent studies recommend caution with high intensity or impact loading on the larger weight-bearing joints if the patient shows significant radiological joint changes. In addition to other signs of inflammation, pain should be a guide to determining the appropriate intensity of the program. Acute pain during exercise indicates a need to modify the program; vague, diffuse pain that resolves in less than 2 hours does not indicate a need for program modification.63 Patients must recognize the signs of an acute flare (i.e., redness, inflammation, pain, and stiffness) and reduce the frequency and intensity of exercise. Exercise prescriptions should include the intensity, frequency, and duration at which each exercise should be performed and take into account the current stage of the disease.

### Orthoses for Rheumatoid Arthritis

Orthoses, splints, and special shoes often are recommended, with the stated goals of relieving pain, reducing edema, providing increased joint stability, and thereby improving overall function. The most commonly prescribed devices are wrist and hand splints, extra depth shoes, and custom or prefabricated insole or foot orthoses.

Wrist and hand splints are categorized as resting splints and working splints (those designed to be worn for functional activities). Such splints can be custom-made for the individual or purchased over the counter. Janssen et al.98 evaluated the effect of using a resting splint on pain, grip strength, and swollen joints and found no difference between use and nonuse. Similarly, Kjeken et al.99 found no differences in pain, stiffness, grip strength or self-reported quality of life between patients who used a working splint and those who did not. However, they did find evidence of some loss of motion while the splint was worn for work tasks. Egan et al.,101 in a recent Cochrane review, concluded that, since working wrist splints do not appear to be detrimental in terms of motion, they might be useful for a degree of pain relief in some patients. They further concluded that the evidence currently is insufficient to support the use of resting splints, although they acknowledged that some patients report a preference for wearing them for comfort reasons during acute exacerbations.

In the foot, a loss of plantar fat and muscle atrophy of interossei often are seen. Along with subluxation of tendons, these can lead to deformities, especially of the forefoot, such as hammer toes and metatarsal subluxation.102 Loss of support for the medial arch from overstretching of repetitively inflamed soft tissues may lead to significant overpronation. Extra depth shoes and shoes made of heat-moldable material are commonly prescribed footwear.103 The extra depth shoe has an additional 0.64 to 0.95 cm (0.25 to 0.38 inch) of volume to accommodate any foot deformities and to allow use of an insert or foot orthosis (Figure 28-9). Inserts in the

### Table 28-7

<table>
<thead>
<tr>
<th>Form of Rheumatoid Arthritis</th>
<th>Recommendations</th>
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</thead>
<tbody>
<tr>
<td>Acute flare (hot joint)</td>
<td>AROM exercises for involved joints, 2 repetitions/joint/day Resting orthoses and assistive devices with built-up handles or platform attachments</td>
</tr>
<tr>
<td>Subacute</td>
<td>AROM exercises, 8 to 10 repetitions/joint/day Static exercises, 4 to 6 contractions lasting 6 seconds each Isotonic exercises with light resistance (avoid if joints are unstable or with tense popliteal cysts or internal joint derangement) Aerobic training, 15 to 20 minutes, 3 times/week. Cardiac evaluation is recommended for men over age 35 and women over age 45. Establish heart rate parameters and use perceived rating of exertion scale (e.g., Borg scale of perceived exertion)</td>
</tr>
<tr>
<td>Stable or inactive</td>
<td>AROM and flexibility exercises Static and dynamic strength training (avoid dynamic exercises if joints are unstable or with tense popliteal cysts) Aerobic training, 15 to 20 minutes, 3 times/week. Cardiac evaluation is recommended for men over age 35 and women over age 45. Establish heart rate parameters and use perceived rating of exertion scale Orthoses: Lower extremity—accommodative or custom foot orthoses in extra depth shoes or moldable shoes; upper extremity—consider working wrist/hand support</td>
</tr>
</tbody>
</table>


AROM, Active range of motion.
form of both accommodative and custom posting often are prescribed. In one study, patients who wore extra depth shoes with a semirigid orthotic for 12 weeks reported less pain than when they wore just an extra depth shoe. Soft inserts were not found to provide any further pain relief over just wearing the extra depth shoe alone. However, in another study, use of a functionally posted, semirigid foot orthosis alone did not appear to make a difference in pain or disability measures compared to a placebo insert.

**Ambulatory Aids and Adaptive Equipment**

Many patients with RA have significant upper extremity joint dysfunction, especially of the hands and wrists, that makes use of a cane, crutch, or walker difficult or painful. An adaptation that can help is the use of platform attachments that distribute weight-bearing forces over the forefoot. Devices with wider, flatter handgrips often are more comfortable than the standard grip. Cone-type handgrips are designed so that the ulnar side of the hand is on the wider part of the cone; this improves grip strength and resists the tendency for ulnar drift or deviation. A low cost alternative is to build up the handgrip of ambulatory aids or utensils and writing implements with moldable foam; this helps prevent compression on vulnerable joints while improving the ability to grip.

**Energy Conservation Techniques**

Because RA is a systemic disease, patients can easily become fatigued. Although all patients should be encouraged to participate in exercise programs as appropriate, educating patients in strategies for conserving energy while performing routine ADLs is equally important. This becomes imperative during periods of exacerbation.

### Energy Conservation Strategies

- Schedule activities so that demanding physical tasks are alternated with less strenuous ones
- Sit to perform tasks when possible
- Gather all necessary supplies before a task
- Limit trips, especially up and down stairs
- Schedule adequate rest periods

In addition, patients should be taught to avoid positions and activities that perpetuate joint deformity. Squeezing a ball for hand exercise should be avoided, because it may contribute to subluxation at the MCP and interphalangeal (IP) joints as a result of excessive force on the ulnar side of the joints. Prolonged flexed positions of the hands and other extremity joints may shorten soft tissue and contribute to contractures.

**Suggestions for Patient Education**

- Provide simple, clear instructions
- Link the exercise or modality to a clear outcome and explain its use
- Provide patients with key symptoms they need to recognize that indicate a flare and the need for exercise modification
- Provide guidelines for modifying an exercise
- Encourage social support for exercise
- Ask patients to explain their expectations and attitudes toward exercise to help determine their willingness to exercise and perceived barriers to exercise

**Case Study in Rheumatoid Arthritis**

Holly is a 38-year-old female who presents with 5 months of bilateral knee, wrist, and hand pain. Upon examination, she exhibits pain (Visual Analogue Scale [VAS] score, 6/10) and 2+ swelling in the PIP joints, MCP joints, and wrist, with limited ROM. Several PIP joints exhibit 15° hypertension, and subcutaneous nodules are evident on the right fourth and fifth PIP joints. Slight ulnar deviation of the MCP joints is seen, left greater than right. Her knees are warm, painful, and swollen, and these symptoms are greater on the left than the right. The patella ballottement test is positive bilaterally. She has restricted ROM in her right knee of 10°. Both feet show hallux valgus and hammer toe deformities. The stiffness and swelling in her fingers, wrists, feet, and knees are worse in the morning, lasting up to 3 hours. By late afternoon, her hands, wrists, feet, and knees are aching, and she states that aspirin does not alleviate her pain. She is having difficulty performing her job as a university professor. Her typing is labored, and she has trouble demonstrating manual skills that require hand dexterity; she also has trouble with prolonged standing while conducting her laboratory courses. She saw her rheumatologist, who prescribed prednisone (10 mg), methotrexate, folic acid, and a multivitamin and referred her to physical therapy.

**Case Discussion**

This patient is in a flare. The prescribed medical therapy—a fast-acting pharmaceutical agent (prednisone) combined with a slow-acting disease-modifying drug (methotrexate)—hopefully will bring the disease under control. Her rehabilitation program should include gentle ROM exercises for the whole body, with special emphasis on her wrist, hands, fingers, knees, and feet. The synovitis evident
in her hands and knees can lead to stretching of the joint capsule and ligaments. With synovitis, biomechanical forces across the joint are increased, and ligaments and tendons can become involved, leading to joint instability. Common changes evident in the hands (the joints commonly involved first) are radial deviation of the wrist, subluxation of the proximal carpal row, and radial rotation of the distal carpal bones. Therefore it is important to check for volar drop of the MCP joints by palpating the heads of these joints in relation to the extended first phalanx. Although flexed posturing generally is more comfortable, flexion can lead to intrinsic tightness. Resting splints for evening and dynamic splints may help maintain alignment during physical activities. Resistive dynamic exercises should be avoided with synovitis. In the hand, forceful squeezing results in joint deformities and may result in pathomechanical changes. ROM and isometric exercises are preferred, along with the use of ice to reduce swelling. A can of food or a cylinder can be used to perform isometric grasping and is preferred to ball squeezing, which can lead to ulnar drift.

Proper footwear that provides adequate support and allows accommodation of her foot deformities should be recommended. An extra depth shoe allows for use of a soft insole with enough room to accommodate the foot deformities. An ergonomic evaluation of her work space and home environment should be done so that recommendations can be made for individualized energy conserving techniques. She may benefit from an ergonomically designed computer keyboard and/or mouse that minimizes ulnar drift and allows an easier grasp. Because prolonged standing is fatiguing, an appropriate supportive chair should be sought. Frequent monitoring of blood pressure is required with the use of steroids, because these drugs can lead to weight gain and subsequent hypertension.

Summary

This chapter discussed the roles of exercise therapy, ambulatory aids, modalities, and orthoses in addressing osteoarthritis and rheumatoid arthritis. The evidence supporting the use of various types of exercise, the strengths and limitations of these studies, and new recommendations were presented. The importance of prescribing the correct frequency, duration, intensity, and type of exercise for the various stages of disease was highlighted, as was the current data on the use of orthoses and appropriately adapted aids and assistive devices. Suggestions were presented for important patient educational material that can be included in the intervention plan.

References

To enhance this text and add value for the reader, all references have been incorporated into a CD-ROM that is provided with this text. The reader can view the reference source and access it online whenever possible. There are a total of 123 references for this chapter.